gienic laboratory will be opened within the next few months, and I expect to give a bacteriological course there. I would suggest informing Dr. Prudden of this opportunity." Arnold's covering letter to this significant enclosure suggests that a preliminary course be taken with Heuppe in Wiesbaden or Frobenius in Munich. He adds, "I was delighted with your letter, because I gather from it that everything is going well with you, and because you give me the hope of seeing you soon." That Prudden's desire to study under Koch was finally achieved is shown by a paper, written in 1885, in which he describes the method of teaching carried out by him.

> Thus the course in the study of bacteria, of one month's duration, in Koch's laboratory was brought to an end, and the writer can not refrain from remarking that the calm, judicial mind of Dr. Koch—the master worker in his field—his marvelous skill and patience as an experimenter, his wide range of knowledge and his modest, unassuming presentation of his views are all calculated to inspire confidence in the results of his own work, to stimulate his students to personal exertion in this field and to lend certainty to the already widespread hope that ere long through the resources of science we shall be able to cope successfully with those most terrible and fatal enemies of the human race—the acute infectious diseases.

Prudden became, therefore, the instrumentality through which the new bacteriology was brought to New York; research was begun and courses of instruction in the subject were at once offered to students; and the tenets of the new science were made practically potent through the influence which Prudden exerted upon the officials of the city department of health and by a well-considered newspaper campaign carried out anonymously over a period of years. It is no accident, therefore, that the department of health of New York presented itself as well advanced in applying to public health measures the teachings of the new hygiene.

The large range of Dr. Prudden's intellectual activities can be gleaned most easily from the list of his published papers and books which, from 1879 to 1914, cover about 100 major titles. The greater number of the papers and books relate naturally to his special field of inquiry, namely, pathology and bacteriology, in the widest sense. The articles and books on American ethnology form a thing apart and show how readily Prudden might have led in archeology, as he did in pathology. His pen was a facile instrument which he could turn at will to the description of detailed and abstruse phenomena or the revealing of fascinating and romantic happenings in the life of the bacteria, the conquest of disease, the past of American aborigines, or indeed any theme which engaged his interest and his thought. His delightful booklets, "The Story of the Bacteria" and "Dust and Disease," were more than messengers of light to the medical profession; they were written in such simple and delightful style that they were read with the absorption of romance by many lay persons, and contributed a large share to that popularization of authentic knowledge upon which the modern practice of sanitation has come to be built. But, as with every scientific man, the most enduring productions are the results of his own efforts to extend the bounds of knowledge; and in that endeavor, Dr. Prudden himself labored through many years and inspired the labors of many others. There stand to his credit and that of his pupils many conspicuous pieces of finished work.

The adventurous and pioneer Prudden did not fail after arduous days to bring back his ship laden with a rich freight of humanitarianism and science. Let this be his monument.

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VASECTOMY AND REJUVENESCENCE

THE skepticism manifested by many biologists concerning the results of vas deferens ligation or vasectomy in producing rejuvenating effects seems abundantly justified from both old and new researches. The Steinach operation has commanded considerable interest because of its rejuvenescence claims, *i.e.*, by the remarkable character of these reported effects of restoring youthful vigor. The explanation usually offered is to the effect that there is produced degeneration of the spermatogenic cells with attendant hypertrophy of interstitial tissue. The latter supposedly causes the rejuvenescence. The primary atrophy of the spermatogenic cells is said to be followed by a subsequent regeneration which relieves the animal of the temporary sterility produced by the ligation.

A review of the literature on vasectomy which has been accumulated since the early eighteen hundreds is especially interesting. Hunter,[1] Cooper,[2] Gosselin[3] and Curling[4] were among the earliest of those interested in pathological change in the testes, epididymis and vas deferens. Part of their interest lay purely in the field of pathological findings together with a

[1] Hunter, "Hunter's Works," Ed. by Palmer, Phila., 1841.

[2] Cooper, "Observations on the Structures and Diseases of the Testis." London, 1845.

[3] Gosselin, Arch. gen. de Med., 1847, S. 4, Vol. XIV, p. 408; "Nouvelles Études sur l'obliteration des voies spermatiques et sur la stérilité consecutive à 'l'épididymite bilaterale." Arch. gen. de Med., S. 5, Vol. II, p. 256.

[4] Curling, "On the Diseases of the Testis," Phila. 1866.

speculative interest in the consequences to the testes of the absence of the vas deferens or of its occlusion. This interest is typified in Curling's experiments upon three dogs and one cat. He found that vasectomy of sixty days to eight months was followed by distension of the epididymis with testicular products, including spermatozoa, and that no changes took place in the testicle proper. Such experiments were looked upon as confirmation of observations made from human dissections where the vas deferens was either prenatally absent or had been occluded for a long time with no marked effect upon the testis. Curling cites a number of such dissections in his book on "Diseases of the Testis."

A little later this interest was increased in an endeavor to find a relief for pathological hypertrophy of the prostate. Some of the earlier workers referred to above were interested in this phase of the study, but the writings of Spangaro and of Wallace are especially to this point. Spangaro[5] found spermatozoa in the testes of three men, twelve days, six months and two and one half years after vasectomy, while Wallace[6] concluded from a review of literature and from a series of experiments on six dogs and one kitten that the growth of the testicle and its function of producing spermatozoa is independent of the integrity of its vas.

Experimental biologists had likewise pursued this line of investigation and had obtained similar results. Brissaud[7] used rabbits as experimental material and found that the epididymis became enlarged because of the accumulation in it of spermatozoa which the testis continued to produce. Shattock and Seligman[8] found that vasectomy on sheep for a period of a year or more produced no degenerative effects in the testes. We thus find in the literature up to this time a general and remarkable unity of results. These early workers found that occlusion of the vas deferens produced no pathological changes in the testis proper. The reader should note the diversity of material studied: rabbits, cats, dogs and human tissue.

[5] Spangaro, "Nel Testicolo Senile conduce la ligatura del dotto deferente all' atrofia dell' orgeno?" *Lo Spermintale,* 1903, an 57, F3.

[6] Wallace, "The results of castration and vasectomy upon the prostate gland in the enlarged and normal condition." Trans. Path. Soc. of London, 1905, Vol. LVI, p. 80.

[7] Brissaud, "Effects de le Ligature du Canal Deferent," Arch. d. Physiol., S. 2, Vol. VII, p. 769.

[8] Shattock and Seligman, "Observations upon the acquirement of secondary sexual characters, indicating the formation of an internal secretion by the testicle," Proc. Royal Soc. of London, 1904, Vol. LXXIII, p. 49.

At about this same period two French biologists, Ancel and Bouin,[9] using rabbits as experimental material, reported that degeneration of spermatogenic tissue always took place if the ligation was continued long enough. They supported their contentions by studies on cryptorchid testes of pigs and showed that the vasectomized and cryptorchid testes were almost identical. These experiments were used by Ancel and Bouin as a link in their proof that the interstitial cells produced the testicular hormone. Steinach confirmed and extended these experiments, claiming to produce by them rejuvenescence. He used rats as experimental material and claimed that when old, senescent animals were vasectomized they showed definite signs of rejuvenescence within twenty-one days. He contended, as did Ancel and Bouin, that the spermatogenic tissue of vasectomized testes underwent degeneration, while the interstitial cells hypertrophied. He then argued that sex activity increased through the enlargement of the "puberty gland"—the interstitial cells. Sand, Tiedje and Lipschutz quickly took up this work on rabbits, rats and guinea pigs. These men, as did Steinach, found degenerative changes in *some* testes, while *in other cases the testes were normal.* Steinach[10] and Tiedje[11] explained these irregularities by stating that degeneration always took place, but that after some time regeneration followed. Sand[12] and Lipschutz[13] explained the irregularities in their experiments by stating that some of the animals used were immature when operated upon and that these alone did not suffer degeneration of the germinal tissue. It is interesting to note that in one report by Sand,[14] in which he presents fifteen vasectomy experiments only two had degenerated testes.

Most of these workers were ignorant of the earlier work or deliberately ignored it. Beginning with Ancel and Bouin, they all used rodents in their ex-

[9] Ancel and Bouin, "Recherches sur les Cellules Interstitielles du Testicule des Mammifères," Arch. d. Zool. Exper., 1903, S. 4, Vol. 1, p. 437.

[10] Steinach, "Verjungung durch experimentalle Neubelebung der alternden Pubertatsdruse." Arch. f. Entwickmeck, 1921, Vol. XLVI, p. 557.

[11] Tiedje, "Changes in testes after ligation." *Deutsch. Med. Wockenschr.,* 1921, Vol. XLVII, p. 352.

[12] Sand, "Études exper. sur les glandes sexuelles chez les mammifères," *Journ. of Physiol.* 1921, XIX, pp. 305, 494 and 515.

[13] Lipschutz, "The so-called compensatory hypertrophy of the testicle after unilateral castration." *Journ. of Physiol.,* 1921, Vol. LV, p. 451.

[14] Sand, "Expériences sur la resection du vas deferens," *J. de Physiol. et de path. gen.,* 1923, XIX, 494–503.

periments. It remained for the writer to show that their choice of experimental animals was particularly unfortunate (Oslund).[15] In these animals (rodents) the testes are free to move from the scrotum into the peritoneal cavity and vice versa. Following ligation or resection of the vas deferens, the testes are often retained in the peritoneal cavity by adhesions. It is this artificial cryptorchidism that causes degeneration of the germinal epithelium. Vasectomy alone does not cause such degenerative changes. In order to carefully test this point several extensive series of experiments of from fourteen days' to ten months' duration were performed upon rats and guinea pigs. Degeneration of the germinal epithelium did not follow ligation of the vas deferens in any experiment of short or long duration where the testes were known to reside in the scrotum following the operation. Degeneration did take place in every experiment where the testes, either uninjured or vasectomized, were retained in the peritoneal cavity.

In a later paper it was shown that vasectomy on dogs does not produce degenerative changes in the testis or hypertrophy of interstitial cells (Oslund).[16] In rodents the inguinal canal is patent, while in carnivora it is closed and vasectomy results are not complicated by the possibility of accidental cryptorchidism produced by the operation. Care was taken to eliminate all extraneous factors, such as diet and confinement. Following closure of the vas deferens, there is an accumulation of testicular products in the epididymis which leads to its distension. An equilibrium between rate of spermatogenesis and absorption of this material is quickly reached, and no degeneration of seminiferous tubules takes place.

A detailed review of the literature bearing upon vasectomy on animals having a closed inguinal canal strikingly emphasized the above points. From such a review it has been pointed out that vasectomy on sheep from seventy-six days to one year, on dogs from sixty days to four years and on man from twelve days to four years has produced no testicular changes (Oslund,[16] p. 117).

What, then, of interstitial cell, "puberty gland," hypertrophy? In a recent paper it has been shown that unless there is degeneration of the germinal epithelium, interstitial cell hypertrophy does not take place (Oslund).[17] The interstitial cells occupy the spaces betwen the seminiferous tubules. Only when these tubules atrophy are these spaces increased in size. It is then quite evident that increase in interstitial cell mass, either in cell number or in cell size, can take place only when these tubules atrophy. When an increase of interstitial cells takes place it is largely regulated by tension and pressure within the testis. Compensatory hypertrophy of interstitial cells is very probably a misnomer and not a reality (Oslund,[17] p. 595).

It then appears that vasectomy causes no changes in the testicle proper. The epididymis becomes somewhat distended with testicular products. There results no degeneration of germinal epithelium and no interstitial cell hypertrophy. The changes claimed to have resulted from vasectomy appear to have been produced by subsequent influences rather than by vasectomy itself.

The theory of rejuvenescence at present is based upon a necessary interstitial cell hypertrophy. Ligation of the vas deferens does not produce such a hypertrophy. Vasectomy, therefore, can not be looked upon as a method of causing rejuvenescence.

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[15] Oslund, "Vasectomy on rats and guinea pigs," *Am. J. of Physiol.*, 1924, Vol. LXVIII, p. 422.

[16] Oslund, "Vasectomy on dogs," *Am. J. of Physiol.*, 1924, Vol. LXX, p. 111.

[17] Oslund, "Interstitial cell hypertrophy," *Am. J. Physiol.*, 1924, Vol. LXIX, p. 589.

THE HARVARD SUMMER SCHOOL OF GEOLOGY

RECENT mention in SCIENCE (August 22, 1924) of the summer school of geology being conducted by Professor Grant, of Northwestern University, moves the undersigned to offer the following account of the Harvard school which was held under Professor Shaler, in camp, on Cumberland Mountain, near Cumberland Gap, on the Kentucky side, in June, July, August and September, 1875. This antedates Professor Grant's camping school 49 years and shows that the idea of a camping school of geology is not new in this country. The names of some prominent men connected with this school or who have since become prominent, especially in science, and some personal reminiscences may not be without interest.

The writer, born within ten miles of the first pig-iron furnace in America, on the trail left by Spotswood and the Knights of the Golden Horseshoe, after leaving the Virginia Military Institute, Lexington, Virginia, reached Kentucky on St. Patrick's day, 1874, when Professor Nathaniel Southgate Shaler, of Newport, Ky., and Harvard College, was directing the reinstated Kentucky Geological Survey begun by David Dale Owen in the early fifties. Professor Shaler conceived the idea of holding the Harvard summer school of geology in connection with the work of the survey the next summer.

Camp Harvard, on the Harlan C. H. road, at the foot of the Pinnacle, some mile or more west of Cum-